**Translation of DE 3,513,515**

# UNDERWATER CRAFT

## Prior Art

This invention arises from an underwater craft of the type described in the main claim. A known underwater craft of this type (DE GM 71 48 617), while it may serve a diver as a driving means, presupposes that the diver is automatically supplied with compressed air. The control rudder is solely operated by electrical means, which can be activated by the diver via a foot switch. In view of the fact that the diver wears flippers, which should make it almost impossible for the diver to operate the switch, it will be no longer possible for him to maneuver, especially surface, the craft when the batteries are drained. Because at least two persons are always involved in diving operations, be it scuba diving or for offshore repairs, at least two similar underwater crafts must be used to comply with the - never dive alone - rule. Not least, with these known underwater crafts, the drive is placed in an unfavorable downward position, so that when landing the craft on a soft ground, it could easily sink in and thus would be rendered useless. With this type of drive, the craft could not be left on a soft ground. Further, the water inlet valves also have a very unfavorable disposition and thus force the diver, whose field of vision is limited in any case, to make out the valves by touch, as they are invisible to the diver.



With another known underwater craft (DE OS 21 00 827), the drive also is activated by electrical means, which are powered by a battery. Prior to starting, the step-on means are so adjusted and remain unchanged, which has the great disadvantage that, when shutting down the craft on the ground, it surfaces after the diver has left the craft, and then drifts off, as a result of which the diver loses the craft. Counterbalancing the craft is extremely difficult, if not impossible. Further, it is difficult to imagine how this type of craft is to be maneuvered by two divers or where on the craft the divers are to be accommodated.

Similar to a different known underwater craft (DE OS 31 18 568), which also is designed to the diver's disadvantage and automatically supplies the diver with oxygen, the diver must hold onto a frame which is deformable via joints, rather than by means of which

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the craft is maneuverable. Apart from the fact that the craft design generates a disproportionate number of wake resistances, it demands that the diver's body adapts to the craft's frame and its joints, as a result of which this underwater craft practically is unuseable, let alone the suggestion of an enclosed cabin, which would be perilous.

**Advantages of the Invention**

The inventive underwater craft comprising the characterizing features of the main claim, by contrast, has the advantage that extraordinarily large compressed air reserves are made available, that two divers are able to dive with one craft, and that both divers can be supplied from compressed air bottles mounted in the craft via one demand air system each, and that

Advantageously adequate compressed air is provided for the drive bodies in the underwater craft to enable multiple diving and surfacing operations. The catamaran-like configuration of the hull, for example, enables the craft to accommodate two large 50-liter compressed air bottles, so that at 200 bar filling compression, there is a reserve of about 20,000 liters breathable compressed air. Theoretically, this air reserve allows both divers to remain submerged for up to five hours, which, for example, may be an advantage when performing offshore repairs on large ships. It is feasible that the divers relieve each other, while the underwater craft remains stationery at the repair site. Four floodable and pressurizable buoyancy bodies with one 175 liter volume each suffice in order to achieve an adequate buoyancy. By integrating the spaces accommodating the compressed air bottles with the buoyancy bodies and their catamaran-type connection, one obtains a relatively large deck for the divers.

According to an advantageous inventive embodiment, the underwater craft comprises a preferable flow-enhancing front shell, which is vaulted for deflecting the divers' flow pressure via the front section of the deck, and consists of a transparent material. Apart from protecting the divers, this cowl also reduces flow resistance, as well as energy consumption during the ride. According to the inventive embodiment, the upper edge of this front cowl is provided with outlets for deaerating the buoyancy body, so that the exhausted air does not impair the divers' vision. The two hull sections can be inventively vaulted in their lower section to accommodate the compressed air bottles, in which the buoyancy bodies are located above the compressed air bottles. The two buoyancy sections, together with the cover of a

watertight tank for accommodating an energy source, which is disposed between the hull sections, form a joint surface which represents the deck of the underwater craft.

According to an advantageous inventive embodiment, the deck is provided with holding means, which automatically hold the diver onto the underwater craft, in which said holding means may serve as T-shaped double hooks, the open ends of which are arched downward, so that the diver, using his lower legs, is able to clamp onto said holding means. This offers the advantage that the deck is adapted to the human anatomy.

According to an additional inventive embodiment, containers or compartments are provided for transporting objects, such as tools. This type of underwater craft design enables to accommodate this type of container without producing flow-impeding projections. Water flows through these containers, so that they cause no change in weight when opening the containers.

According to another inventive embodiment, skids are provided at the underside of the underwater craft, so that the craft can easily be pulled along the ground in the water without becoming stuck on uneven surfaces. Further, these skids enable the craft to be pulled and left both on land and under water.

The front section of the deck may be inventively designed as a cockpit, in that the control means for adjusting the rudder and for aerating and deaerating the buoyancy bodies are accommodated. These control means can operate electrically, preferably, however, mechanically, so that in case of an electrical failure, a mechanical, i.e., random control is possible. These control means or control valves offer the advantage to be designed as safety elements with automatic reset and/or quick-acting stop device.

According to an additional inventive embodiment, the craft overall is designed to be flow-enhancing, in which the rear end of the craft is tapered. This tapered section changes into a tubular section in which the electrically-driven screw rotates. This end section also accommodates the elevator and vertical rudder, so that the flow conducted along the deck of the craft is divided directly by these rudders.

Other advantageous embodiments and inventive advantages are described in detail in the following description, the drawing and the claims.

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An example of the inventive underwater craft is shown in the drawing, and is described in detail in the following:

Fig. 1 shows an elevation of the craft;

Fig. 2 shows a longitudinal section through the craft according to line II-II in Fig. 1; and

Fig. 3 shows a cross-section through the craft according to line III-III in Fig. 1.

**Description of the Example**

As is indicated in Figures 1 to 3, the inventive underwater craft comprises a flow-enhancing outer skin with separating walls inside the skin, as a result of which a number of closeable or watertight compartments are created. The basic structure corresponds to a catamaran, the hulls 1 of which are interconnected by the chambers which form the housing parts 2. The hulls 1 respectively accommodate a 50-liter compressed air bottle 3 and are separated into buoyancy chambers 4 and 5 by a wall 6, which are located thereabove. The space around the compression bottles 3 of these hulls 1 can be flooded, in order not to effect undesirable buoyancy. Like with the other flooded chambers, it suffices if the outlets in the outer skin are always open. The hulls are provided with downward arched skids 7, in order to prevent the outer skin of the hulls 1 from being damaged when the underwater craft touches down and in order to achieve an improved gliding and standing quality on the bottom of the sea or on land. The hulls 1 are interconnected via a base plate 8, in which the permanently open flood outlets 9 are provided for the buoyancy chambers 4 and 5. Towards the top, the underwater craft is closed by a cover plate 10, which serves as a deck 2 in the longitudinal direction of the adjacent prone divers and correspondingly is adapted to the human anatomy to offer optimum comfort in a prone position. A leakproof battery compartment 12, which is closed by a removable cover 13, is provided between the left and right buoyancy chambers 4, 5. A transparent cowl 14 is provided in the front section above the cover plate 10, in order to protect the diver during the ride and also to improve the craft's hydrodynamics.

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The instrument panels used by the divers are placed on the cover plate 10 under this cowl 14. The control elements 16 for maneuvering the underwater craft are accommodated in a space 15 under the cover plate 10, i.e., in the direction of travel, before the buoyancy chambers 4, 5.

A vertical rudder 17 is provided at the stern of the underwater craft and vertically thereto an elevator 18 in a recess of said vertical rudder. In the crossing area of these two rudders, a concentric nozzle 19 is provided which is mounted to the wall of the underwater craft, and in which a screw 21 rotates which is driven by an electric motor 20. In the area of the concentric nozzle 19, both rudders 17 and 18 comprise corresponding recesses and at their lateral front ends respectively are rotatably suspended with the arms 22 and 23 which are connected with the hull of the craft. The cables, such as Bowden cables, which are necessary to operate the rudders 17 and 18, run into these arms 22 and 23.

To enable the divers to hold onto the craft, at the cover plate 10 T-shaped straps 24 are provided in the area of the lower legs of the divers, behind which the divers inserts their lower legs. Further, hand grips 25 run laterally to the cover plate 10, to which the divers are able to hold on when boarding or leaving the craft or with which the craft can be pulled guided over solid ground or guided when floating on water.

Based on the proportions of the underwater craft in relation to the diagram, the battery compartment 12 can hold nine batteries, such as eight 6 V 250 A drive batteries to energize the electric motor 20, such as a 48 V low-voltage DC drive motor. The ninth 12 V 120 A battery is used for lighting purposes. A known 1800 W 48 V electric motor for offshore operation can be used as drive motor. The motor's speed and change in the direction of rotation is controlled by the diver. The required control elements are placed on an instrument panel 27 under the cowl 14, so that the instruments (not shown) always are in full view and reach of the diver. The energy consumption can be minimized by means of an electronic control. The instrument panel 27 also is provided with a battery status indicator.

Two lamps 28 are permanently fixed in the bow of the underwater craft, which the diver can switch on with the switches placed on the instrument panel, and are powered by the 12 V battery. The battery loading sockets are housed in the battery compartment 12, so that no short-circuit discharge resulting from water can occur. Further, this ensures that the battery compartment 12 is opened during every reloading operation, so that potential leaks are checked and there is adequately aeration. The cover plate 10 of the underwater craft

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may, if appropriate, be covered with leakproof, inserted solar cells, in order to recharge the batteries when the craft is not in operation. In that case, the corresponding loading device is accommodated in the battery compartment 12.

The vertical rudder 17 and the elevator 18 can be operated mechanically by hand or pneumatically. Working cylinders serve as pneumatic means which apply the motion-transmitting means, such as Bowden cables, and which are supplied with compressed air via valves. The valves are operated directly by the diver and are placed on the instrument panel 27. The working means, that is, air, which is taken from the compressed air bottles, is reduced via a pressure-reducing valve. The mechanical working means function correspondingly, in that the diver also operates a control lever, which, however, immediately engages the transmission means, such as the Bowden cable. This control level also is placed on the instrument panel 27. The direct mechanical operation, above all, saves compressed air, and in addition there is an emergency control option, for example, when there is insufficient compressed air for the control.

For practical reasons, the control lever, be it for mechanical or pneumatic control, is moved in the usual manner for the corresponding operation, namely pressed forward when the craft is to dive, and pulled back for surfacing operations. By shifting the lever to the right, the vertical rudder 17 goes into position for a right-hand turn, and when shifting it to the left, it goes into position for a left-hand turn.

The mechanical control allows an automatic reset into the neutral rudder position, so that a change in direction can be effected only so long as the diver holds the control lever in a corresponding position. With pneumatic control, using opposite controls, like when maneuvering an aircraft, is necessary to return the rudder into neutral position.

The surfacing and diving operations of the underwater craft also are controlled by the levers on the instrument panel 27, which activate the valves, so that in one setting compressed air flows from the compressed air bottles 3 into the buoyancy chambers 4, 5, and in the other setting the air contained in the buoyancy chambers 4, 5 is exhausted. Water flows through the flooding outlets 9 either when deaerating the buoyancy chambers 4, 5 or when diving the craft and correspondingly releasing air from the chambers 4, 5. Because the craft has four chambers, namely two left and two right, which respectively can be aerated or deaerated independently from each other, weight differences in the craft can be balanced by a corresponding arbitrary air volume control, i.e., when creating a unilateral load, as a result of

operating the craft with only one diver, or a unilateral load resulting from tools. The diver thus is able to lift or lower the craft very sensitively in varying degrees towards starboard or port, the stern or the bow.

As a safeguard against losing the craft due to loss of compressed air, a pressure control device is provided in the air system which, corresponding to a certain depth and similar ambient pressure, for example, at 70 m depth, automatically applies air to the buoyancy chambers 4, 5, in order to force the underwater craft to surface as a result of slow and safe buoyancy contingent upon automatically applied air.

The advantageous and practical application of the underwater craft demands that an oxygen device is provided for each diver on either side at the instrument panel 27, which the diver uses during the diving operation, in spite of being equipped with his own device. This will often enable the diver to save the compressed air in his own bottle for operations outside the underwater craft. The oxygen controllers (demand air systems)are not shown here, but preferably are placed on the instrument panel 27. Changing the mouthpiece from the onboard demand air system to the diver's own system is unproblematic, because there always is a certain excess air pressure. As is known, with these demand air systems, the air pressure is controlled automatically according to the ambient pressure, i.e., at greater depths the air pressure is set higher than at shallower depths.

For all oxygen-consuming components of the underwater craft, namely demand air systems, rudder control, buoyancy chamber supply, the pressurized compressed air is supplied from the bottles 3, after passing through a pressure-reduction valve, to an air distributor (not shown) from which the corresponding lines branch off to the individual oxygen-consuming components. But the consumed air is collected in an air collector, which also is not shown, in order to be fed through hoses into an exhaust pipe 30, such as a rectangular tube, which forms the rear closure of the cowl 14. From there the air can flow to the surface, without impeding the diver's sight.

In addition to the described indicators and instruments, additional indicators, such as bathometers and air level indicators, etc., are placed on the instrument panel 27.

As is indicated in the description, the advantages of the underwater craft, above all, are its wide scope of application. Because of its design, the craft may be used both for scuba diving and offshore repair operations or even military purposes. The underwater craft may

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also be used as an offshore repair craft for underwater repairs in that tools may be stored in any compartments of the remaining unused space, in which these compartments may certainly be flooded, so that the diver or fitter may travel to the repair site, without using considerable air reserves from his own oxygen tank on the journey to the site. The possibility this underwater craft offers to use oxygen from the craft's compressed air tank while traveling to the site and to save the diver's own oxygen supplies has a deciding significance. Consequently, the diver is able to remain submerged with up to 10 hours of oxygen supply and, above all, is able to dive up and down without being put at risk, which, as is known, must be done slowly to allow the human body to adjust to pressure changes.

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